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**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | WO 99/37539 A1 | BE INTELLECTUAL PROPERTY, INC. - whole document but see abstract, paragraph bridging pages 5 & 6 and Figure 4. | 1, 4 - 7 |

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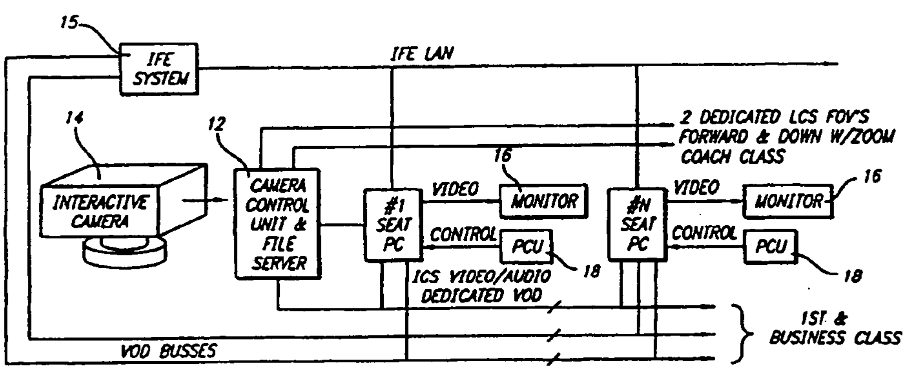


(57) Abstract

The improved landscape camera system (10) for use in aircraft utilizes digital video technology to obtain multiple fields of view that are selectable for viewing by passengers on the aircraft, from either a single video frame or from multiple cameras with different fields of view. The camera module (14) can also receive video input from one or more auxiliary video cameras, such as a vertical fin mounted video camera, i.e. directed forward for a view of the aircraft in flight, or a rearward looking belly mounted camera.

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# IN FLIGHT CAMERA SYSTEM WITH ELECTRONIC FIELD OF VIEW SWITCHING

## BACKGROUND OF THE INVENTION

Field of the Invention:

This invention relates generally to video camera systems for commercial aircraft, and more particularly relates to a closed circuit television system having one or more cameras providing multiple fields of view exterior to the aircraft to provide video to existing passenger entertainment video systems.

Description of Related Art:

Commercial airlines now provide in flight entertainment (IFE) systems with video on demand (VOD) and digital audio/video on demand (AVOD), allowing airline passengers to choose a video or audio selection for their in flight entertainment. One video option that can be made available is a view from a video camera of the environment outside the aircraft during flight. One conventional exterior video camera system, for example, provided camera views through a window provided forward of the nose wheel.

A variety of views can also be made available in a closed circuit television from multiple video cameras, as is disclosed in U.S. Patent 5,574,497, which is incorporated by reference in its entirety herein. Two cameras were housed in a single sealed module, with one camera directed approximately forward toward the horizon, and a second camera directed downward, as is illustrated in Figs. 1a and 1b depicting the general arrangement of camera views in the prior art system. Each camera in this system employed a CCD imager configured as either a camera head unit (CHU) remotely mounted in the aircraft structure, and a companion electronics unit designated as a camera control unit (CCU) located in an electronics and equipment (E&E) bay of the aircraft, or as a single module with the CHU and CCU

integrated as a camera module unit (CMU). As is illustrated in Figs. 1a and 1b, the camera housing unit 3 is structurally integrated into the fuselage skin 1. This structural integration includes an optical grade window 5, and the camera head units 4, 7. The installation area shown is located in a structural bay bounded by frames 2, 8. When the remote mounting of the CCU in the E&E bay is eliminated, cable weight is reduced by over 95%, yielding an overall weight savings in excess of 40 lbs. for a typical B-747-400 aircraft installation.

The fields of view available from such conventional video cameras were interfaced to the onboard video entertainment systems as an analog signal, essentially allowing the passenger to select the fixed fields of view provided by the video cameras mounted on board the aircraft. A typical field of view arrangement available with the prior art dual camera design is shown in Fig. 2. The two fields of view are: 1) Forward Looking, described by angle FBG, and 2) Downward Looking, described by angle HBI. The camera fields of view are aligned along two references; the forward looking camera along a horizontal reference described by line AC, and the downward looking camera long a vertical reference described by line DE, which is perpendicular to the horizontal reference. This optical combination produces an angular field of view range from 7.5° (H) by 5.75° (V) to 3.8° (H) by 2.8° (V). The lens combinations described provide the optical characteristics required in order to minimize the size of the structural window 5, shown in Fig. 1b. However, changing of the fields of view of a video camera such as by panning the camera resulted in a change of the field of view for each passenger viewing the selected camera video view, and individual passenger control for each passenger to select different fields of view was not possible.

It would be desirable to provide a closed circuit television system making multiple fields of view available for selection by passengers on the aircraft, either from a single video frame from a single video camera, or from multiple video cameras providing views individually selectable by passengers on the aircraft. The present invention meets these needs.

## SUMMARY OF THE INVENTION

Briefly, and in general terms, the present invention provides for an improved landscape camera system for use in aircraft, that utilizes digital video technology to obtain multiple fields of view that are selectable for viewing by passengers on the aircraft, from either a single video frame or from multiple cameras with different fields of view. In one presently preferred embodiment, the video camera module receives video input from a video camera having a 140° field of view lens that can be rotated 90° about a mounting axis that is perpendicular to a tangent to the surface of the aircraft, providing a maximum angular size of the video frame that is approximately 140° horizontally and 128° vertically, which is 90° from the normal aspect ratio orientation of the lens. The camera module can also receive video input from one or more auxiliary video cameras, such as a vertical fin mounted video camera, i.e. directed forward for a view of the aircraft in flight, or a rearward looking belly mounted camera.

The invention accordingly provides for a closed circuit television system for an aircraft, providing at least one video camera with a field of view forward and downward from the aircraft's centerline, and generating a digital video signal providing a plurality of video images. A video camera control module connected to the at least one video camera and a plurality of video display modules for receiving and displaying the digital video signal provides a plurality of selected video images to the plurality of video display modules, respectively.

In one presently preferred embodiment, a video camera provides a plurality of fields of view from a single video frame. In another preferred embodiment, the plurality of fields can be provided by a plurality of video cameras, such as by providing additional video input from one or more auxiliary video cameras, such as a vertical fin mounted video camera, i.e. directed forward for a view of the aircraft in flight, or a rearward looking, belly mounted camera.

These and other aspects and advantages of the invention will become apparent from the following detailed description and the accompanying drawings,

which illustrate by way of example the features of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a is an illustration in plan form of the location of prior art exterior view camera systems for aircraft;

Fig. 1b shows a prior art arrangement of dual, forward and downward viewing cameras for aircraft;

Fig. 2 shows typical prior art fields of view available with a dual camera system;

Fig. 3 illustrates a first embodiment of the closed circuit television system for an aircraft of the present invention, showing the range of the multiple fields of view available from a single video camera; and

Fig. 4 is a schematic diagram of the closed circuit television system for an aircraft of Fig. 3.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

While commercial airline in flight entertainment systems with video on demand and digital audio/video on demand, can provide airline passengers with fixed fields of view of the environment outside the aircraft during flight from one or more video cameras mounted on board the aircraft, individual passengers have heretofore been unable to independently select different fields of view of a video camera.

As is illustrated in the drawings, the invention is embodied in an improved landscape camera system for aircraft. The landscape camera system utilizes digital video technology to obtain multiple fields of view that are individually and independently selectable for viewing by passengers on the aircraft, from either a single video frame or from multiple cameras with different fields of view. Referring to Figs. 3 and 4, in one presently preferred embodiment of a landscape camera system 10, a video camera control unit and file server unit 12 receives video input from a video

camera 14 typically having a 140° horizontal by 128° vertical field of view lens that can be rotated 90° about a mounting axis JK that is perpendicular to a tangent LM to the surface of the aircraft, providing a maximum angular size of the video frame that is approximately 140° vertically and 128° horizontally, which is 90° from the normal aspect ratio orientation of the lens. The file server unit 12 houses a remapper board and SEB. The video camera is typically interactive, providing five separate images from five different sensors in the video camera that are stitched together to create an omniview frame by the camera control unit. Referring to Fig. 3, the horizontal and vertical references are the same as those for Fig. 2. However, the new reference line LM and the reference line JK are used for the angular alignment of the landscape camera system. The angle NBO represents the 140° field of view with its center aligned along line JK.

Alternatively, the camera sensor can provide a hemispherical image, with a field of view of 182° in all directions, for example. The field of view results in an image of a minimum of 1° above the horizon in all directions. The hemispherical image, along with any audio component, is distributed to each seat on a dedicated 175mb bus provided by the AVOD system. The software program required for processing the hemispherical image is downloaded to each seat via the IFE LAN. The IFE LAN also provides any dewarping of the image data and perspective correction to each seat. Utilizing the microprocessing power at each seat provided by the AVOD IFE system allows each passenger to maneuver within this hemispherical image to select any desired field of view, independent of all other passengers. The interactive camera system camera sensor is preferably a 2 million pixel sensor, with matrix filter 59% utilized, with 2,000 horizontal x 1,500 vertical active picture elements, providing 1.76 million active pixel elements utilized.

Referring again to Fig. 4, the landscape camera system 10 also includes an in flight entertainment (IFE) system 15 connected to video and audio display units located at each of the passenger seat position (#1 SEAT PC, #N SEAT PC...) by an in flight entertainment local area network (IFE LAN) such as is available from Matsushita or Sony. Each passenger seat video and audio display unit preferably includes a video monitor 16 and a personal control unit (PCU) 18 for operating the

interactive camera system video /audio dedicated video on display system. The interactive landscape camera system enables each passenger with in-seat audio/video on demand capability to electronically pan, tilt, and zoom the field of view of the landscape camera system camera independently of all other passengers. The field of view domain is generally from horizon to horizon left and right, as well as forward and aft. Some passenger areas, such as Coach Class for example, may only be provided with dedicated fields of view on dedicated channels. Typically Coach Class seating is provided with only two dedicated landscape camera system fields of view, namely the forward and down views, with an optional zoom. The downward field of view will typically have a zoom capability under either manual control from the cabin crew or from ARINC 628 RS 485 communication from the in flight entertainment system or directly from an ARINC 429 bus. First Class and Business Class additionally can include an interactive camera system that provides a high resolution, real time, full motion television system that provides interactive operation of the camera from a remote location. The VOD busses provide the real time video frames, at a rate of 30 frames pers second (fps) to each seat. Existing airline closed circuit television non-interactive landscape camera systems can typically be accomplished by replacement of the previously installed camera module unit with an interactive camera system camera module, and the addition of an interactive camera system camera control/file server unit. The interactive camera system can be fully interfaced with in flight entertainment video on demand systems, systems providing interactive and passive advertising, interactive systems providing information about tours and points of interest, arrival and destination video, and the like.

Alternatively, the camera module can receive video input from a plurality of high resolution video cameras, in a system that complies with the standards of the proposed ARINC 628 guidelines. The ARINC 628 compliant landscape camera system is currently the preferred baseline configuration for the aircraft closed circuit television landscape camera system according to the invention. The system provides for ARINC 628 compatible control from the in flight entertainment system, or alternatively, discrete control from a dedicated system control unit.

The camera module can also receive video input from one or more auxiliary video camera module units, such as a vertical fin mounted video camera, i.e. directed forward for a view of the aircraft in flight, or a rearward looking belly mounted camera. The vertical fin camera is preferably a fully integrated video camera installed in a sealed housing. The camera utilizes a circular connector for its electrical interface, and requires a 155 volt AC power input, and a synchronization input. The output of the camera is typically a differential composite NTSC 1 V p-p-3.58 MHz video signal. The degree to which the field of view centerline may be adjusted in relation to the horizon is limited due to the aerodynamic design of the housing and its window. This camera typically uses a fixed 3.7mm lens, but other types of focal length lenses are also available.

The ARINC 628 compliant landscape camera system can also be interfaced with a central video processing unit (CVPU) to provide text and graphics augmentation of video output. The additional CVPU typically provides full ARINC 429 interface capability, text and graphics interface with other information systems, such as the PAX flight information display system (PFIDS), for displaying points of interest, a capability of automatic system disable over sensitive areas, and interactive features described above. The CVPU is typically mounted in the electrical bay of the aircraft, and contains a microprocessor control board, a video I/O board, a system I/O board, a video processor board, a power supply module, and a camera control board. Expansion slots are also available for other boards, and the CVPU is controlled internally by a microprocessor and software.

The CVPU accepts inputs from the video camera units, as well as other information systems available directly to the aircraft in flight entertainment system, such as from individual video switch outputs. These videos also feed an input video switch to provide a fourth output, and the control of the video input switch may also be controlled by aircraft flight phases, as discussed above. Provisions for a moving map display input video are a standard interface for the CVPU as described above. This additional video input is handled within the CVPU as if it were another video camera input. When the moving map video is integrated with the other video camera inputs, the output options to the in flight entertainment system include: 1) the map

display may be a part of a sequential display which cycles through a preset order of camera and map video displays; 2) the map display may be integrated into a split display of camera video and map information; 3) the display of map information and video camera views may be combined in various ways for different zone presentations.

An additional feature of this system is the ability to receive text data from moving map systems for integration into the video camera display. Interfaces can include: 1) insert Point of Interest (POI) identifying text into current video camera displays as a label, such as of two lines of text, for example; 2) insert or overlay scrolling POI text into or on current video camera display; 3) utilize the database of the moving map display system as a video camera deactivation signal while overflying sensitive political areas.

It will be apparent from the foregoing that while particular forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

WHAT IS CLAIMED IS:

1. A closed circuit television system for an aircraft, said system comprising: at least one video camera providing a field of view forward and downward from the aircraft's centerline, said at least one video camera generating a digital video signal providing a plurality of video images; a plurality of video display modules for selecting and displaying a selected video image; and a video camera control module connected to said at least one video camera and said plurality of video display modules for receiving said digital video signal and providing a plurality of selected video images to said plurality of video display modules, respectively.

2. The system of Claim 1, wherein said at least one video camera comprises a video camera providing a plurality of fields of view from a single video frame.

3. The system of Claim 1, wherein said at least one video camera comprises a video camera having a 140° field of view lens that can be rotated 90° about a mounting axis that is perpendicular to a tangent to the surface of the aircraft, providing a maximum angular size of the video frame that is approximately 140° horizontally and 128° vertically, and which is 90° from the normal aspect ratio orientation of the lens.

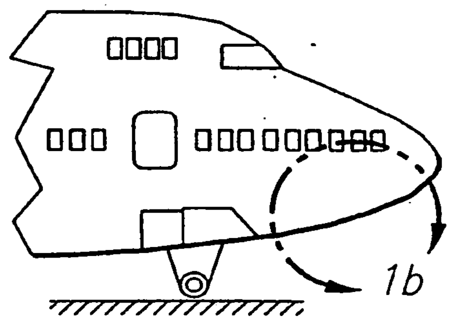
4. The system of Claim 1, wherein said at least one video camera comprises a plurality of video cameras.

5. The system of Claim 4, wherein said plurality of video cameras further comprises an auxiliary video camera.

6. The system of Claim 5, wherein said auxiliary video camera comprises a vertical fin mounted video camera directed forward for a view of the aircraft in flight

7. The system of Claim 5, wherein said auxiliary video camera comprises a rearward looking belly mounted camera.

FIG. 1a
PRIOR ART



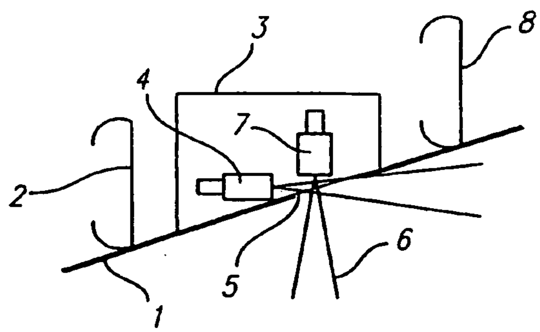
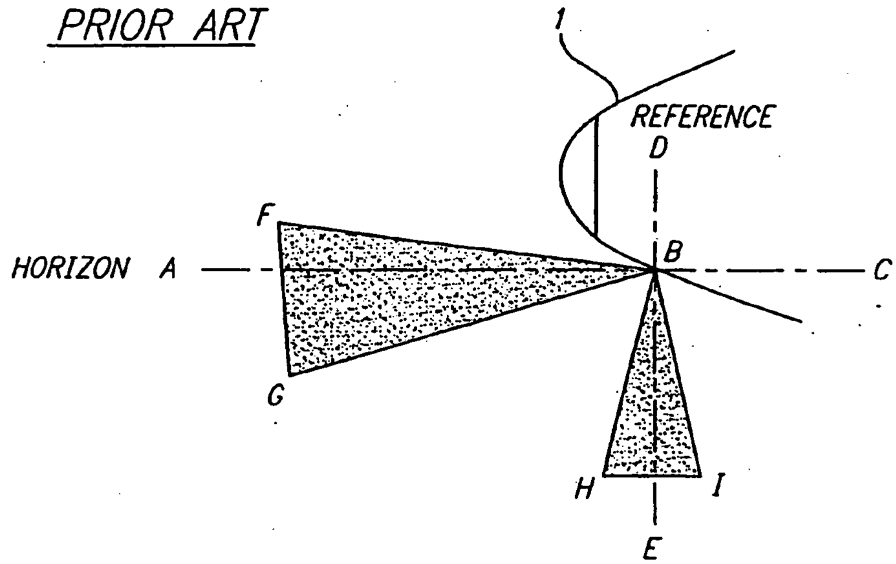




FIG. 1b
PRIOR ART

FIG. 2
PRIOR ART



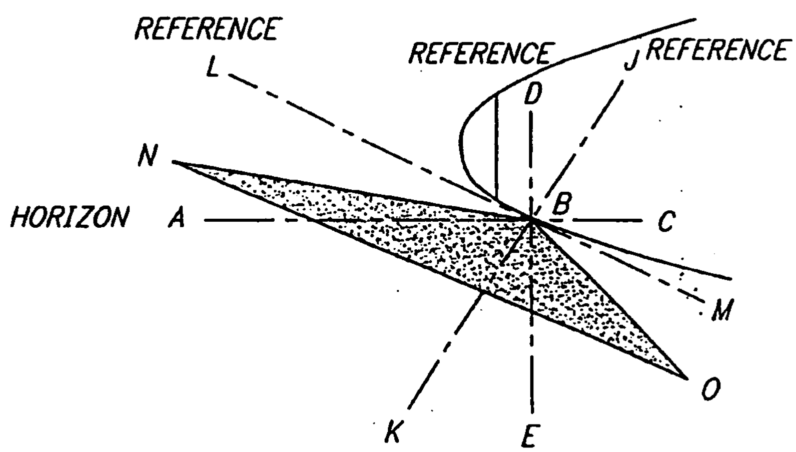
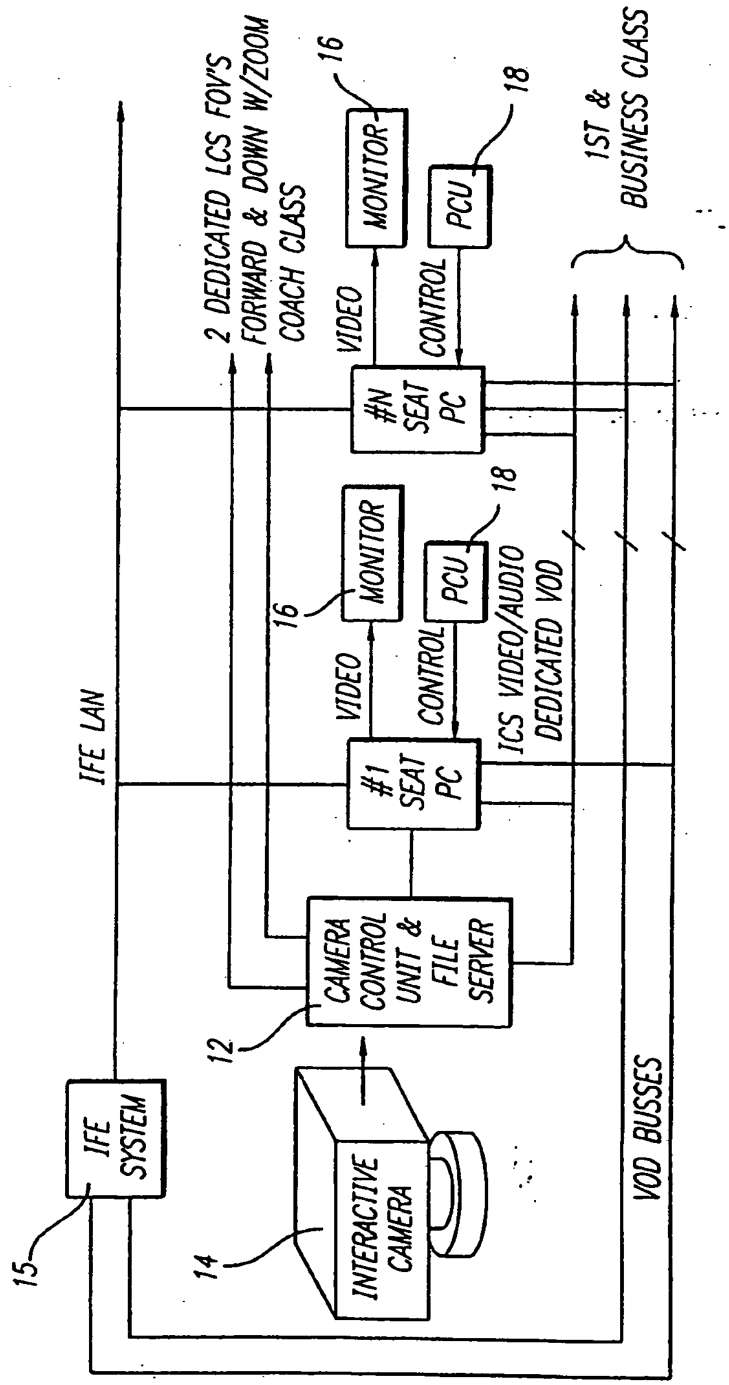




FIG. 3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MONITOR
VIDEO
18
PCU
CONTROL
#N SEAT PC
1ST &
BUSINESS CLASS
IFE LAN
16
MONITOR
VIDEO
18
PCU
CONTROL
ICS VIDEO/AUDIO
DEDICATED VOD
#1 SEAT PC
12
CAMERA CONTROL UNIT & FILE SERVER
15
IFE SYSTEM
14
INTERACTIVE CAMERA
VOD BUSSES

FIG. 4